

## SURVIVAL SURGERY AND POSTSURGICAL CARE

### 7.1 **Introduction:**

Aseptic surgery should be conducted only in facilities intended for that purpose. These facilities must be maintained and operated to ensure cleanliness and directed and staffed by trained personnel.

Appropriate facilities and equipment should be available for postsurgical care.

Minor surgical procedures, such as wound suturing and peripheral vessel cannulation, can be performed under less stringent conditions if they are performed in accordance with standard veterinary practices. (Guide for the Care and Use of Laboratory Animals)

### 7.2 **Definitions:**

**Aseptic technique:** A surgical technique conducted under conditions which prevent exposure of the patient to pathogenic organisms. The technique includes wearing sterile surgical gloves, gowns, caps, and face masks; the use of sterile instruments; and the aseptic preparation of the surgical field (NRC, 1985, p. 37).

**Survival surgery:** Surgery performed on an anesthetized animal, after which the animal is expected to regain consciousness.

**Major survival surgery or major operative procedure:** A survival surgical intervention that penetrates a body cavity or potentially produces a permanent handicap in an animal. (NRC, 1985, p. 37):

**Minor surgical procedure:** A surgical procedure restricted to the management of minor problems and injuries (e.g., wound suturing, peripheral vessel cannulation).

**Non-survival surgery:** A surgical procedure where an anesthetized animal is euthanized at the end of the procedure without regaining consciousness.

### 7.3 **Legal Requirements:**

All surgery must be performed or directly supervised by trained, experienced personnel.

Any procedure that will cause more than momentary or slight pain or distress must be performed with the use of appropriate sedatives, analgesics, or anesthetics, unless withholding such agents is justified for scientific reasons and that justification is provided to the institutional animal care and use committee in writing by the Principal Investigator.

Pre- and postsurgical care must be provided in accordance with established veterinary medical and nursing practices.

### **Survival Surgery:**

The AWRs require that aseptic surgical techniques be used on all regulated animals. (9 CFR 2.31)

PHS policy requires compliance with the Guide for the Care and Use of Laboratory Animals, which recommends that survival surgery on rodents be conducted using sterile instruments, surgical gloves, and aseptic procedure. (NRC, 1985; PHS, 1986) See also (ARAC Guidelines, March 9, 1994)

Major surgical procedures on nonrodents must be conducted only in facilities that are intended for that purpose and are maintained under aseptic conditions. (9 CFR 2.31; PHS, 1986)

Non-major operative procedures, operative procedures conducted at field sites, and all surgical procedures on rodents, do not require a dedicated facility but must be performed using aseptic procedures. (9 CFR 2.31)

Multiple major surgical procedures on one animal may not be performed unless one of the following conditions is met:

The procedures are justified for scientific reasons and have been approved by the institutional animal care and use committee.

The justification must be stated in writing by the Principal Investigator.

The procedures are necessary to protect the health or well-being of the animals, as determined by the attending veterinarian.

There are special circumstances that have been approved by the administrator of the Animal and Plant Health Inspection Service, U.S. Department of Agriculture, on an individual basis.

### **7.4 Preparation for Surgery:**

#### **Animal:**

Hair should be clipped from the surgical site. Manipulate electric clippers very carefully because the skin of most laboratory animals is very thin and easily abraded or torn by clipper blades.

The operative site should be thoroughly cleaned with a germicidal soap to remove surface debris and bacteria.

Tape or lightweight strings should be used to secure an animal's limbs and hold the animal in position on the operating table or board.

The animal should be positioned with the head and neck fully extended to ensure a patent airway. An endotracheal tube should be inserted whenever possible.

Surgical drapes should be used to cover the animal's body to prevent contamination of the operative site. When a drape is used over a rodent, rabbit or other small animal, the drape must be positioned carefully to permit visualization of the animal's respiratory movements and peripheral perfusion to avoid anesthetic accidents.

**Surgeon:**

A cap and face mask must be donned first.

Hands and arms are scrubbed thoroughly with germicidal soap prior to donning sterile gloves and, when appropriate, a surgical gown.

**Surgical Instruments:**

All instruments should be wrapped in packs and sterilized prior to surgery.

The date should be written on the outside of each pack when it is sterilized.

Unopened instruments packs should be resterilized periodically. The length of time that packs will remain sterile depends on the method of sterilization (eg. steam or gas) and the type and thickness of the material in which the instruments are wrapped.

**7.5 Anesthesia:** (see Anesthesia & Analgesia tab)

**7.6 Surgical Complications:**

**Hypothermia:** Abnormally low body temperature caused by inadvertent loss of body heat or purposeful chilling of the animal. (Lumb and Jones, 1984)

Effects:

A fall in blood pressure due to decreased cardiac output, despite an increase in peripheral vascular resistance.

Occasionally, a severe drop in blood pressure is caused by a depression of the sinoatrial node and bundle of His.

Ventricular fibrillation, most frequently following a drop in heart muscle temperature below 28°C.

Prolonged clotting time.

Occurrence:

Hypothermia occurs more rapidly in small rodents and rabbits than in larger animals because the smaller animals have a greater ratio of body surface to body mass. Rabbits also have very efficient heat-dissipation surfaces in their ears and rodents' ears, feet, and tail function in a similar manner.

When abdominal or thoracic organs/tissues are exposed to room temperature for prolonged periods. Organs and tissues should be covered with warm, wet lap sponges throughout the surgical process to maintain homiothermic conditions.

**Prevention:**

Cover the animal with surgical drapes and place a layer of insulation between the animal's body and the surgery table to prevent body heat from being lost.

Circulating hot water blankets are safer than electric pads for placement under an animal's body because electric pads may cause localized overheating and tissue damage.

Small, readily sanitizable plastic boards placed on top of steel table surfaces help prevent loss of body heat during surgery on rodents and other small species.

**Dehydration:**

Dehydration, without hemorrhage, usually is caused by excessive loss of body water when abdominal or thoracic tissues are exposed to room air for prolonged periods.

Prevented by using warm, wet lap sheets or sponges over exposed tissues during the surgical process.

Administering isotonic electrolyte solutions intravenously during surgery maintains normal body fluid balance. Fluids administered postoperatively can reverse dehydration.

**Hemorrhage:**

Uncontrolled bleeding is usually caused by inadequate or improper use of hemostatic techniques during surgery.

Hemorrhage may result, however, from intercurrent disease or the use of drugs (eg. heparin and coumarin) that prolong bleeding times.

Excessive hemorrhage during surgery and postoperatively is best prevented by proper blood vessel ligation and/or electric cautery.

Hemorrhage should be treated by locating the source of bleeding and properly sealing the open end of the vessel(s).

Sometimes the application of pressure, manually or with a bandage, over the area of hemorrhage may be adequate.

The use of agents such as vitamine K, that enhance blood clotting, may be useful in certain cases.

Intravenous fluid replacement or blood transfusion may be indicated when a large amount of blood has been lost.

### **Incision Dehiscence:**

Postsurgically, incisions may open spontaneously, because improper suture material was used, sutures were improperly placed, suture knots were not tied properly (squarely and tightly), or when healing has been compromised by localized tissue inflammation.

Good surgical technique (eg. maintain aseptic field, gentle tissue handling, proper suturing mechanics, minimizing hemorrhage) is essential for preventing this complication from occurring.

Dehisced incisions must be properly cleaned, debrided and resutured immediately to prevent further damage to local tissue. When the incision was made through wall of a body cavity, rapid repair is essential also to prevent evisceration.

Parenteral and/or local antibiotics may be necessary to control concomitant bacterial infections.

### **Anesthetic Overdose:**

Most anesthetic accidents occur as the result of improper calculations of drug dosage or improper agent administration. Knowledge of the drugs being used and the expected response of the animal species to the drug, along with careful monitoring of the animal during the induction phase, are essential for prevention. Appropriate treatment depends on the anesthetic used and the symptoms exhibited. (see 6.1.9)

## **7.7 Incision Closure:**

It is important to match both needle size and the type and size of the suture material to the procedure being done. This facilitates wound healing.

Multiple layers of sutures placed in an interrupted pattern are preferred to a continuous pattern. This minimizes the risk of dehiscence.

A subcuticular suture pattern is advantageous for skin closure in animals that are inclined to chew or otherwise remove stitches. The absence of protruding suture material with this pattern reduces the attraction of the incision site as a focus for exploration and self-manipulation.

Knots used to join the ends of suture material must be tied squarely and securely to prevent spontaneous loosening during the healing process.

Metal clips can be used in lieu of sutures to close skin incisions.

## **7.8 Postsurgical Care:**

Trained personnel should observe the animal from the time surgery is completed to the time the animal has recovered from anesthesia enough to attain sternal recumbancy.

The animal should be kept warm, quiet, and clean throughout the immediate postoperative period. This facilitates the metabolism of the anesthetic agents and maximizes healing.

Supplemental fluids, analgesics, and other drugs should be administered as needed.

Special diets, housing, and environmental requirements (e.g. temperature and humidity) should be considered to maximize the postoperative recovery.

If large volumes of balanced electrolytes or other fluids are administered subcutaneously, the injections should be made at multiple sites to prevent tissue damage.

Antibiotics should be used only when needed to treat postoperative infections. They must be carefully selected to avoid specific species intolerances.

Remove external sutures or wound clips at the appropriate time.

Notes on the daily monitoring of the animal's progress, medication administration, and surgical incision management (up to the time of suture removal), should be recorded in the clinical record.

The development of a postoperative care protocol should be done in consultation with the attending veterinarian.

A " crash kit" containing a variety of drugs and equipment that may be needed in the case of a medical emergency should be available in the immediate area where postoperative care is given.

## **7.9 Equipment:**

The type needed to properly support a surgical procedure is dependent on a number of variables. These include the species of animal, the nature of the surgical procedure, and the anesthetic agent used.

Circulating water heating pads and heatlamps are helpful for preventing hypothermia.

Nebulized liquids are helpful in relieving pulmonary congestion.

Vacuum (suction) equipment is useful for removing accumulations of mucus from the respiratory tract and fluid from body cavities.

Oxygen administration facilitates the maintenance of normal pulmonary function and increases the rate of tissue repair.

A mechanical respirator (ventilator) should be available to support respiration when the animal's respiratory system is compromised, or when the animal is unable to breathe normally on its own.

A cardiac monitor is useful for evaluating heart rate and pattern.

An electronic thermometer is helpful for monitoring body temperature.

A gas anesthetic machine or an airtight anesthesia chamber is essential for the administration of volatile anesthetics. Some form of gas-scavenging system should be provided to remove excess anesthetic gas from the room.

An electrocautery unit is useful for managing hemostasis during surgery.

An esophageal stethoscope is useful for monitoring heart and lung sounds during surgery.

#### **7.10 Records:**

A permanent record should be established for each animal undergoing surgery.

The record should be complete, current, and readily accessible.

A brief description of the surgical procedure should be recorded and should reflect what was approved by the institutional animal care and use committee.

Any unexpected or abnormal reaction to anesthetics or other drugs should be recorded.

Any information that might be of value or assistance for maintaining the animal after surgery should be recorded.

All postsurgical care provided should be documented in the animal's record.

#### REFERENCES

ARAC Guidelines. 1994: NIH Intramural Research Program Guidelines for Survival Rodent Surgery. Approved March 9.

Code of Federal Regulations, Title 9 (Animals and Animal Products), Subchapter A (Animal Welfare), Parts 1-3. Copies available from: Animal Care Staff, Regulatory Enforcement and Animal Care, Federal Building, Room 268, Hyattsville, MD 20782.

Lumb, W. V., and E. W. Jones. 1984. *Veterinary Anesthesia*, 2nd ed., Philadelphia: Lea & Febiger. 693 pp.

NRC (National Research Council). 1985. *Guide for the Care and Use of Laboratory Animals*. A report of the Institute of Laboratory Animal Resources Committee on Care and Use of Laboratory Animals. NIH Pub. No. 86-23. Washington, D.C.: U.S. Department of Health and Human Services. 83 pp.

PHS (Public Health Service). 1986. *Public Health Service Policy on Humane Care and Use of Laboratory Animals*. Washington, D.C.: U.S. Department of Health and Human Services. 28 pp. Copies available from: Office for Protection from Research Risks, Building 31, Room 4B09, National Institutes of Health, Bethesda, MD 20892.

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## Appendix: Guidelines for Survival Rodent Surgery

This appendix includes definitions, tables of information, and references as a resource for investigators.

### DEFINITIONS:

**ASEPTIC SURGICAL PROCEDURES:** Surgery performed using procedures that limit microbial contamination so that significant infection or suppuration does not occur.

**MAJOR SURGERY:** Any surgical intervention that penetrates and exposes a body cavity; any procedure that has the potential for producing permanent physical or physiological impairment; and/or any procedure associated with orthopedics or extensive tissue dissection or transection.

**MINOR SURGERY:** Any surgical intervention that neither penetrates and exposes a body cavity nor produces permanent impairment of physical or physiologic function. Examples are superficial vascular cutdown, and percutaneous biopsy.

**STERILIZATION:** The process whereby all viable microorganism are eliminated or destroyed. The criterion of sterilization is the failure of organisms to grow if a growth supporting medium is supplied.

**DISINFECTION:** The chemical or physical process that involves the destruction of pathogenic organisms. All disinfectants are effective against vegetative forms of organisms, but not necessarily spores.

**Table 1. RECOMMENDED HARD SURFACE DISINFECTANTS** (e.g., table tops, equipment) Always follow manufacturer's instructions.

NAME	EXAMPLES *	COMMENTS
Alcohols	70% ethyl alcohol 85% isopropyl alcohol	Contact time required is 15 minutes. Contaminated surfaces take longer to disinfect. Remove gross contamination before using. Inexpensive.
Quaternary Ammonium	Roccal®, Cetylcide®	Rapidly inactivated by organic matter. Compounds may support growth of gram negative bacteria.
Chlorine	Sodium hypochlorite (Clorox® 10% solution) Chlorine dioxide (Clidox®, Alcide®)	Corrosive. Presence of organic matter reduces activity. Chlorine dioxide must be fresh (<14 Days old); kills vegetative organisms within 3 minutes of contact.
Aldehydes	Glutaraldehyde (Cidex®, Cide Wipes®)	Rapidly disinfects surfaces. Toxic. Exposure limits have been set by OSHA.
Phenolics	Lysol®, TBQ®	Less affected by organic material than other disinfectants.
Chlorhexidine	Nolvasan®, Hibiclens®	Presence of blood does not interfere with activity. Rapidly bactericidal and persistent. Effective against many viruses.

\* The use of common brand names as examples does not indicate a product endorsement.

**Table 2. SKIN DISINFECTANTS** Alternating disinfectants is more effective than using a single agent. For instance, an iodophore scrub can be alternated 3 times with an alcohol, followed by a final soaking with a disinfectant solution. Alcohol, by itself, is not an adequate skin disinfectant. The evaporation of alcohol or alcohol based products, (e.g., Alcar, etc.) can induce hypothermia in small animals.

NAME	EXAMPLES *	COMMENTS
Iodophors	Betadine®, Prepodyne®, Wescodyne®	Reduced activity in presence of organic matter. Wide range of microbicidal action. Works best in pH 6-7.
Cholorhexidine	Nolvasan®, Hibiclens®	Presence of blood does not interfere with activity. Rapidly bactericidal and persistent. Effective against many viruses. Excellent for use on skin.

\* The use of common brand names as examples does not indicate a product endorsement.

**Table 3. RECOMMENDED INSTRUMENT STERILANTS** Always follow manufacturer's instructions.

AGENTS	EXAMPLES	COMMENTS
Physical: Steam sterilization (moist heat)	Autoclave	Effectiveness dependent upon temperature, pressure and time (e.g., 121°C for 15 min. vs 131°C for 3 min).
Dry Heat	Hot Bead Sterilizer Dry Chamber	Fast. Instruments must be cooled before contacting tissue.
Ionizing radiation	Gamma Radiation	Requires special equipment.
Chemical: Gas sterilization	Ethylene Oxide	Requires 30% or greater relative humidity for effectiveness against spores. Gas is irritating to tissue; all materials require safe airing time.
Chlorine <sup>1</sup>	Chlorine Dioxide	A minimum of 6 hours required for sterilization. Presence of organic matter reduces activity. Must be freshly made ( <14 days )
Aldehydes <sup>1</sup>	Formaldehyde (6% sol.) Glutaraldehyde	For all aldehydes: many hours required for sterilization. Corrosive and irritating. Consult safety representative on proper use. Glutaraldehyde is less irritating and less corrosive than formaldehyde.

<sup>1</sup> Instruments must be rinsed thoroughly with sterile water or saline to remove chemical sterilants before being used.

**Table 4. RECOMMENDED INSTRUMENT DISINFECTANTS** (Always follow manufacturer's instructions)

AGENT	EXAMPLES	COMMENTS
Alcohols	70% ethyl alcohol 85% isopropyl alcohol	Contact time required is 15 minutes. Contaminated surfaces take longer to disinfect. Remove gross contamination before using. Inexpensive.
Chlorine <sup>1</sup>	Sodium hypochlorite (Clorox® 10% solution) Chlorine dioxide (Clidox®, Alcide®)	Corrosive. Presence of organic matter reduces activity. Chlorine dioxide must be fresh (<14 days old); kills vegetative organisms within 3 min.
Chlorhexidine	Nolvasan®, Hibiclens®	Presence of blood does not interfere with activity. Rapidly bactericidal and persistent. Effective against many viruses.

<sup>1</sup> Instruments must be rinsed thoroughly with sterile water or saline to remove chemical sterilants before being used.

**Table 5. SUTURE SELECTION**

SUTURE *	CHARACTERISTICS AND FREQUENT USES
Vicryl®, Dexon®	Absorbable; 60-90 days. Ligate or suture tissues where an absorbable suture is desirable.
PDS® or Maxon®	Absorbable; 6 months. Ligate or suture tissues especially where an absorbable suture and extended wound support is desirable
Prolene®	Nonabsorbable, Inert.
Nylon	Nonabsorbable. Inert. General closure.
Silk	Nonabsorbable. (Caution: Tissue reactive and may wick microorganisms into the wound). Excellent handling. Preferred for cardiovascular procedures.
Chromic Gut	Absorbable. Versatile material.
Stainless Steel Wound Clips, Staples	Nonabsorbable. Requires instrument for skin removal.

\* The use of common brand names as examples does not indicate a product endorsement.

**Suture gauge selection:** Use the smallest gauge suture material that will perform adequately.

**Cutting and reverse cutting needles:** Provide edges that will cut through dense, difficult to penetrate tissue, such as skin.

**Non-cutting, taper point or round needles:** Have no edges to cut through tissue; used primarily for suturing easily torn tissues such as peritoneum or intestine.

## **REFERENCES**

- Animal and Plant Health Inspection Service, USDA. 1991. CFR Title 9, Subchapter A- Animal Welfare. U.S. Government Printing Office, Washington, D.C.
- Atkinson, L.J. 1992. *Berry & Kohn's operating room technique*, 7th ed. Mosby, St. Louis, MO.
- Bennett, B.J., Brown, M.J., and Schofield, J.C. 1990. *Essentials for animal research, a primer for research personnel*. National Agricultural Library, Beltsville, MD.
- Block, S.S., 1983. *Disinfection, sterilization, and preservation*, 3rd ed. Lea & Febiger, Philadelphia, PA.
- Boyce, John. 1992. Rodent surgery conference highlights animal-care issues. *JAVMA*. Vol 201, No. 1.
- Bradfield, J.F., Schachtman, T.R., McLaughlin, R.M., and Steffen, E.K. 1992. Behavioral and physiological effects of inapparent wound infection in rats. *Lab. Anim. Sci.* 42(6): 572-578.
- Brown, M.J., Pearson, P.T., and Tomson, F.N. 1993. Guidelines for animal surgery in research and teaching. *Am J Vet Res.* 54(9): 1544-1559.
- Coligan, John E. 1991. *Current Protocols in Immunology*. New York, Greene Pub. Associates and Wiley-Interscience. Volumes 1 and 2, QR183.C976.
- Cunliffe-Beamer, T.L. 1993. Applying principles of aseptic surgery to rodents. *AWIC Newsletter*. 4(2): 3-6.
- Dahl, J., Wheeler, B., and Mukherjee, D. 1990. Effect of chlorhexidine scrub on postoperative bacterial counts. *Am J Surg.* 159(5): 486-488.
- Fluknell, P.A., and Liles, J.H. 1991. The effects of surgical procedures, halothane anaesthesia, and nalbuphine on locomotor activity and food and water consumption in rats. *Laboratory Animals* 25:50-60.
- FOUNDATION FOR BIOMEDICAL RESEARCH. 1988. *Biomedical Investigator's Handbook for Researchers Using Animals: Chapter 3 - Surgery: Protecting your animals and your study*.
- Garner, J.S., and Favero, M.S. 1986. CDC guidelines for the prevention and control of nosocomial infections, guideline for handwashing and hospital environmental control, 1985. *Am J Infect Control.* 14(3): 110-129.
- Loew, F.M., Bennett, B.T., 1987. Blake, D.A., Cunliffe-Beamer, T., Hughes, H.C., Pakes, S.P., Simmonds, R., and Strandberg, J.D., (ed). *models*. Foundation for Biomedical Research, Washington, D.C.
- Meeker, M.H., and Rothrock, J.C. 1991. *Alexander's care of the patient in surgery*. Mosby, St. Louis, MO.
- National Research Council. 1985. *Guide for the care and use of laboratory animals*. NIH publication no. 85-23. Public Health Service, Bethesda, MD.
- Popp, Martin B. and Brennan, Murray F. 1981. Long-term vascular access in the rat: importance of asepsis. *Amer. J. Physiol.* Vol. 421, No. 4:H606-H612.
- Rutala, W.A. 1990. APIC guideline for selection and use of disinfectants. *Am J Infect Control.* 18(2): 99-117.
- Waynforth, H.B. 1992. *Experimental and surgical technique in the rat*. 2nd Ed. Academic Press, London, UK. Video Tape - Laboratory Animal Training Association, Aseptic Surgery of Rodents, LATA 1989 (Available in Office of OACU - NIH)